A Power Move: A Proposal for the Installation of a Photovoltaic System at TransAlta's Kananaskis Site

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Motivation

- Our project provides an alternative power solution that
  - decreases station service costs by reducing peak loads, and
  - can be used in case of emergencies or backup power requirements.
- The finalized designs will be given to TransAlta to implement on the site seen in Figure 1.
- From a recorded peak load of 55 kW over 15 minutes on site in 2018, we aim to provide 90% capacity (44 kWh).

Figure 1. TransAlta Kananaskis Hydro Plant.

Panel

- We will be using Canadian Solar 600 Wp solar panels.
- Monofacial panels will be used.
- In Figure 2, panels will use a single axis tracker which increases efficiency by 10%.

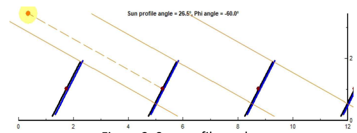

Figure 2. Sun profile angle.

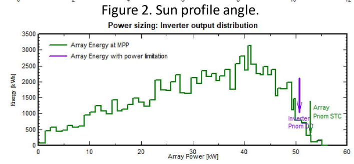

Figure 3. Inverter array sizing efficiency graph.

- The Sungrow SG40 inverter which converts AC to DC at 98% efficiency will connect the panels and the battery to the step-down transformer.

Battery

- We considered lead acid, lithium-ion and vanadium redox flow (VRF) batteries.
- VRFBs are commonly used for off grid applications and although have a high upfront cost, make up for this in substantially longer lifetime and a full depth of discharge capability. Costs are compared in Figure 4 and Table 1.

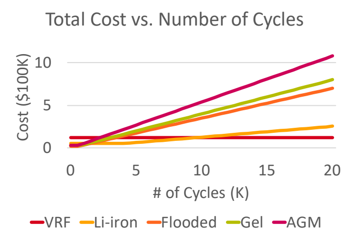

Figure 4. Comparison of battery total cost to cycle lifetime.

Battery	Cost/kWh
VRF	$0.11
Li-iron	$0.23
Flooded	$0.64
Gel	$0.73
AGM	$0.98

Table 1. Comparison of battery cost per kWh.

Finalized Design and Simulations

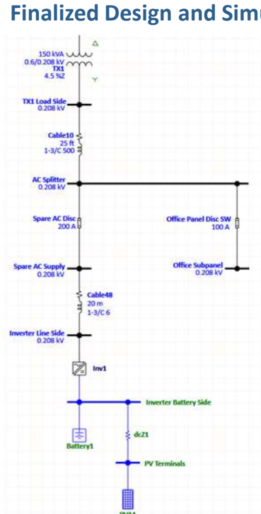

Figure 5. Etap diagram of finalized circuit.

- Our finalized design is shown in Figure 5 and contains
  - A total of 80 panels, with 20 panels on 4 strings. Each string produces 11 kWp and connects to the batteries and inverter.
  - A vanadium redox flow battery producing 120 VDC and 110 kWh capacity.
  - An inverter with 4 Maximum Power Point Tracker (MPPT) inputs to accommodate each string and outputs a maximum of 44 kW. The size of the inverter was chosen with the maximum array output in mind to minimize system losses as seen in Figure 3. The output of the inverter is connected to the transformer.
  - A 75 kVA transformer which steps down 400 V to 208 V which is connected to the rest of the site's station service.
- The panels will be mounted on the roof of the site shown in the 3D model below (Figure 6).
- Losses were simulated in PVsyst and shown in Figure 7.

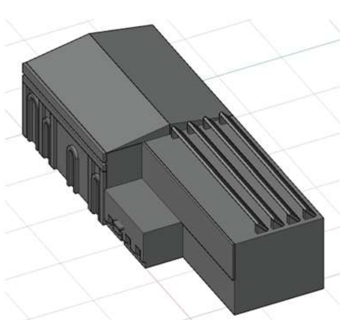

Figure 6. 3D model of panels on roof site

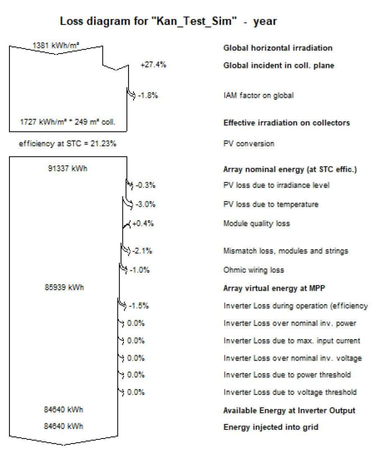

Figure 7. Loss diagram of Pvsyst simulation.

Transformer

- We utilize the 75 kVA RC75G1-B Canada Transformers Three Phase Autotransformer to step down voltage from 400 V to 208 V.
- Primarily for economic reasons, the Autotransformer utilizes a Y-Y configuration since we are providing a balanced load and the sensitivity of the system is not a large concern.

Cost Analysis

- We broke down the cost of our proposal into paneling, installation, insurance and servicing costs for an approximated lifetime of 25 years for the panels.
- The cost breakdown for year 1 is shown below in Table 2.

Breakdown	Cost (CAD)
System Parts	$279,039.00
Installation	$13,000.00
Insurance Coverage	$32,631.70
System Servicing	$2,537.60
Total Cost for Year 1	**$327,208.30**

Table 2. Estimated total cost of system for year 1.

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